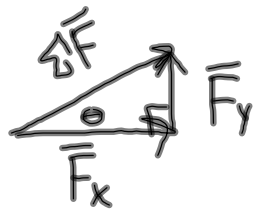


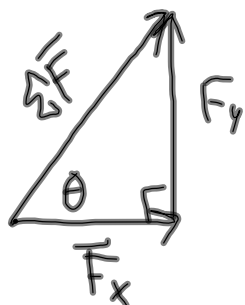
## Pulling or Pushing at an angle:

- Pulling/pushing horizontally requires the least amount of force
- As the angle increases, the total amount of force also increases
- The amount of force in the x-direction is the same, but the force in the y-direction increases

$\longrightarrow \vec{F}_x$  horizontal



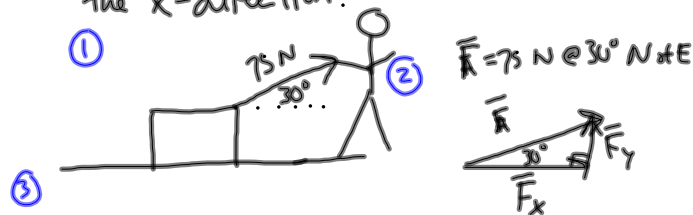
smaller angle



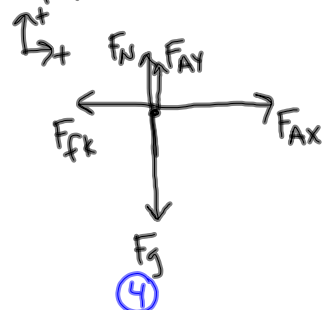
large angle

# Pulling at an Angle Notes and Problems 3.9.12 CP Physics

A person pulls a box (mass = 20 kg) with a force of 75 N at angle of 30°. The box is on a surface that has a coefficient of friction ( $\mu_k$ ) of 0.33. What is the acceleration of the box in the x-direction?



FBD:



$$F_x = F \cos(30^\circ) = 64.95 \text{ N}$$

$$F_y = F \sin(30^\circ) = 37.5 \text{ N}$$

$$\sum F_x = m a_x$$

$$a_x = \frac{\sum F_x}{m} = \frac{F_{Ax} - F_{fk}}{m} = \frac{64.95 \text{ N} - 52.3 \text{ N}}{20 \text{ kg}} = 0.633 \text{ m/s}^2$$

⑤

$$F_{fk} = \mu_k F_N$$

$$= (0.33)(158.5 \text{ N})$$

$$= 52.3 \text{ N}$$

⑥

$$\sum F_y = m a_y$$

$$F_N + F_{Ay} - F_g = 0$$

$$F_N = F_g - F_{Ay}$$

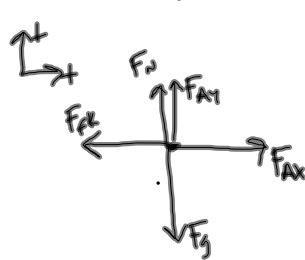
$$= m a_y - F_{Ay}$$

$$= (20 \text{ kg})(9.8 \text{ m/s}^2) - 37.5 \text{ N}$$

$$= 158.5 \text{ N}$$

# Pulling at an Angle Notes and Problems 3.9.12 CP Physics

A box is pulled at a constant velocity,  
 and the box has a mass of 10 kg. If  
 the person pulls with a force of  
 20 N at  $45^\circ$ , what is the coefficient  
 of kinetic friction between the box  
 and the floor?



$$F_{Ax} = F \cos(45^\circ)$$

$$= 14.14 \text{ N}$$

$$F_{Ay} = F \sin(45^\circ)$$

$$= 14.14 \text{ N}$$

$$F_{fk} = \mu_k F_N$$

$$\mu_k = \frac{F_{fk}}{F_N}$$

$$= \frac{14.14 \text{ N}}{83.86 \text{ N}}$$

$$= 0.168$$

$$\sum \vec{F}_x = m \vec{a}_x \rightarrow \emptyset$$

$$F_{Ax} - F_{fk} = \emptyset$$

$$F_{fk} = F_{Ax}$$

$$= 14.14 \text{ N}$$

$$\sum \vec{F}_y = m \vec{a}_y \rightarrow \emptyset$$

$$F_N + F_{Ay} - F_g = \emptyset$$

$$F_N = F_g - F_{Ay}$$

$$= m a_g - F_{Ay}$$

$$= (10 \text{ kg})(9.8 \text{ m/s}^2) - 14.14 \text{ N}$$

$$= 83.86 \text{ N}$$